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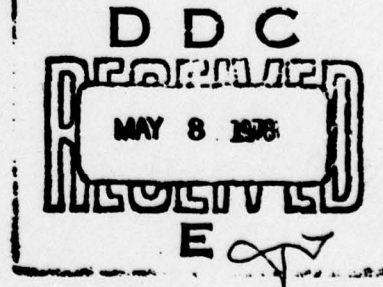
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DESIGN TESTING OF A SMALL FEEDWATER PUMP

D. DYETT

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Mechanical Engineering Technical Memorandum 387.

DESIGN AND TESTING OF A
SMALL FEEDWATER PUMP.

by

D. Dyett

SUMMARY

This memo records the design and testing of a small positive displacement feedwater pump, required in connection with experiments on steam atomisation of liquid fuels.

The pump is a four-cylinder radial type, direct coupled to a variable speed drive. The design flow rate of 20 litres/hour was satisfactorily achieved with minimal pulsing.

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This memo records the design and testing of a small positive displacement feedwater pump required in connection with experiments on steam atomisation.

The pump is of four cylinder radial type direct coupled to a variable speed drive. The design flow rate of 20 litres per hour at 1400 kPa was satisfactorily achieved with minimal pulsing.

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1. INTRODUCTION

One method of atomising fuel oils for combustion is by means of steam jets. The need to supply steam for a proposed series of combustion experiments in the Division has created a requirement for a special pump to deliver feedwater to the steam raising apparatus. This memorandum records the design, building and testing of a pump to meet this need.

2. DESIGN REQUIREMENTS

The design was to be kept simple so that parts would be easy to manufacture and where possible use was to be made of components which were at hand.

The application called for a positive displacement pump having a variable rate of delivery up to a maximum of about 20 litres/hour at delivery pressures up to 1400 kPa with a minimum of pulsing.

All parts in contact with the water were to be resistant to corrosion.

3. DESCRIPTION

Details of the pump may be seen in Figs. 1, 2 and 3. Fig. 2 shows the radial layout of the four bronze cylinders each having a bore of 11.05 mm. The four piston rods are driven outwards on the delivery stroke by the eccentric which is hard chromed and has a lift of 7 mm. Provision for varying the delivery is by changing the speed of rotation by means of a 'Kopp' variable speed transmission.

The return stroke of the pistons is accomplished by a spring which also serves to keep the roller cam followers in contact with the eccentric. Alignment of the cam followers is maintained by a flat surface on each rod which bears on a rubbing plate as shown in Figs. 1 and 3.

The main casing and front and rear cover plates are machined from aluminium. Each cover plate provides a mounting for the bearings and in addition the front one supports the rubbing plate and the shaft seal.

All static joint faces are sealed by paper gaskets; the rotating seal on the shaft is a 'Fla-seal', and the reciprocating seals in the cylinders are two 'o' rings with a vent to atmosphere between them.

Lubrication is by means of oil contained in the casing, the level being determined by the position of the filler plug. Mounted externally on each cylinder are two check valves which use the pressure differential across spring loaded poppets to control the flow. All inlet and outlet valves are connected to respective common manifolds.

The pump is mounted with the drive shaft horizontal, the cylinders inclined at 45 degrees to the horizontal and with the connections so arranged that the inlet is at the lowest point and the delivery at the highest in order to facilitate the purging of air from the system.

The pump itself may be rotated in either direction although the present variable speed drive may be rotated in one direction only.

4. METHOD OF TESTING

The variation of flow rate with pump speed was determined by measuring the time taken to fill a known volume at a constant delivery pressure. One series of readings was taken at 700 kPa and one at 1400 kPa.

During testing some trouble was experienced due to the setting of needle valves changing slightly with time so that for the purpose of testing it was found best to set the required delivery pressure after each change of speed by deforming a piece of hypodermic tubing installed in the delivery line. This technique eliminated any drift in pressure which was found to occur when a needle valve was used.

A pressure transducer was fitted in the delivery line and the resulting waveform displayed on an oscilloscope. The waveform at the speed required to give the design flow was photographed and is shown in Fig. 4.

5. RESULTS AND DISCUSSION

Fig. 5 shows the variation of flow with speed of rotation for the

two pressures used. The flow is seen to depend linearly on the speed of rotation and to be independent of the pressure. Comparison of the theoretical flow rate based on the displacement with that observed gave a volumetric efficiency of about 90%.

The defect in efficiency is thought to be due to losses during the opening and closing of the inlet and outlet valves.

Fig. 4 indicates that pressure pulses at the design speed and pressure will be about 55 kPa peak to peak amplitude as would be expected for this type of pump and this is thought to be acceptable for the duty envisaged.

On completion of test running the pump was dismantled and examined. No signs of corrosion or excessive wear could be seen.

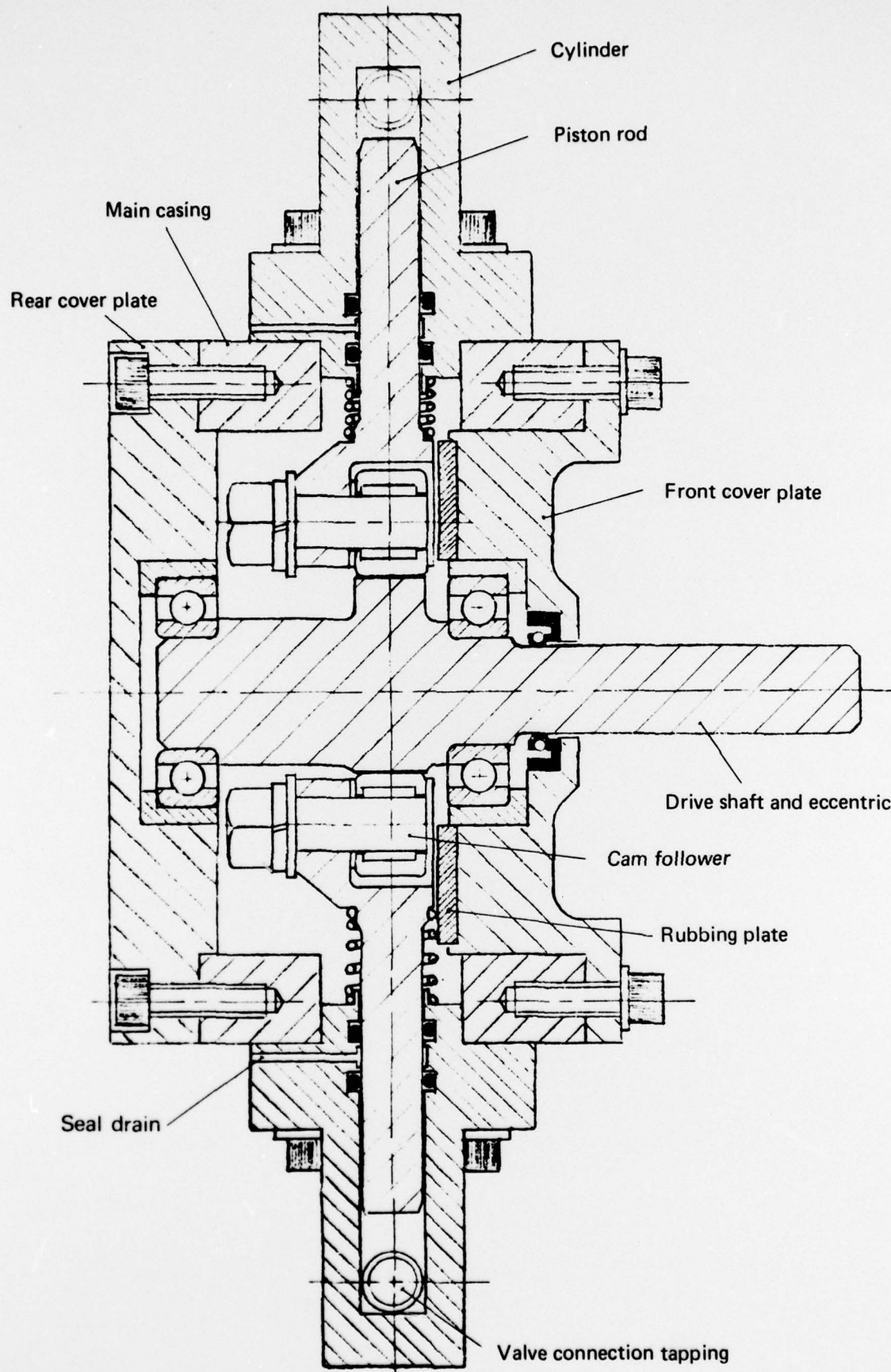


FIG. 1. SECTION DRAWING — scale full size

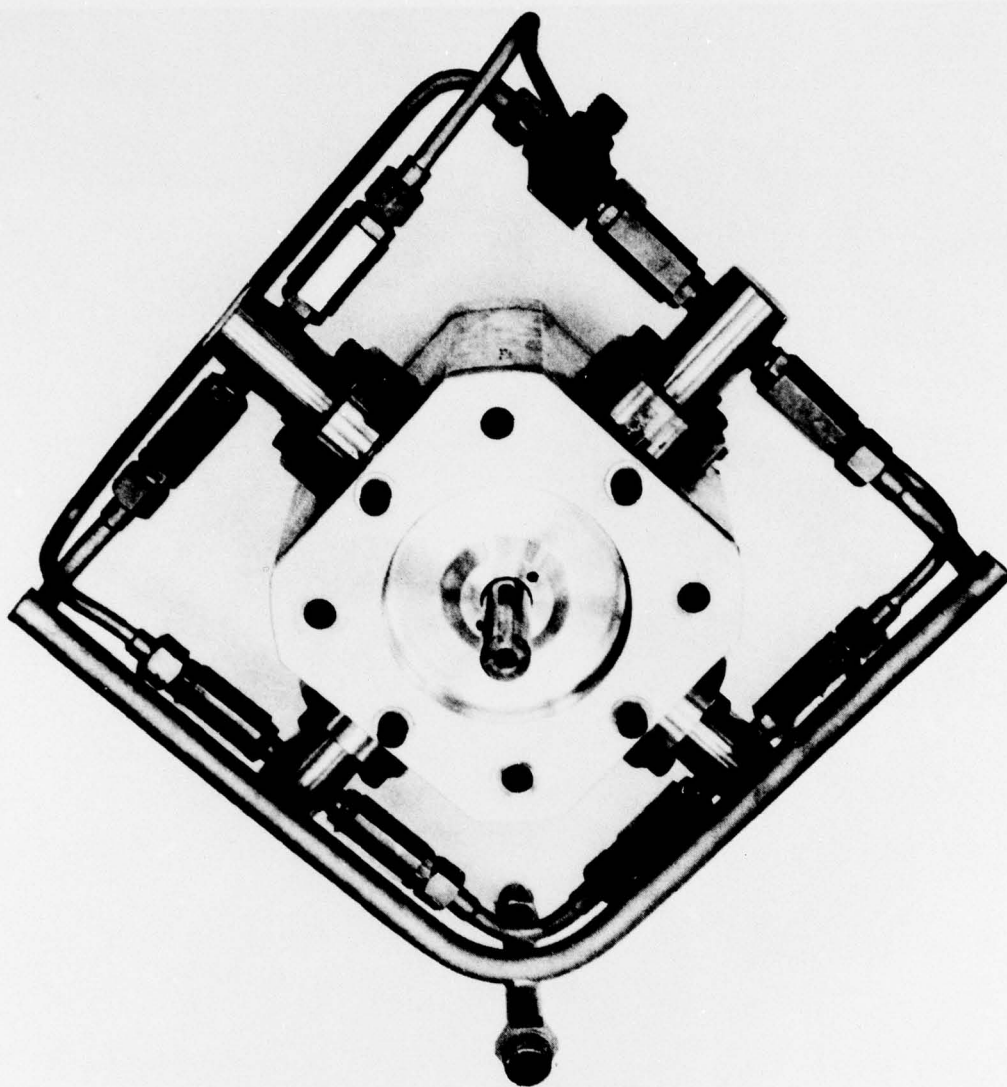


FIG. 2. FRONT VIEW OF REDUCED SCALE SHOWING ORIENTATION OF PUMP AND LAYOUT OF CYLINDERS, CHECKVALVES AND PIPING

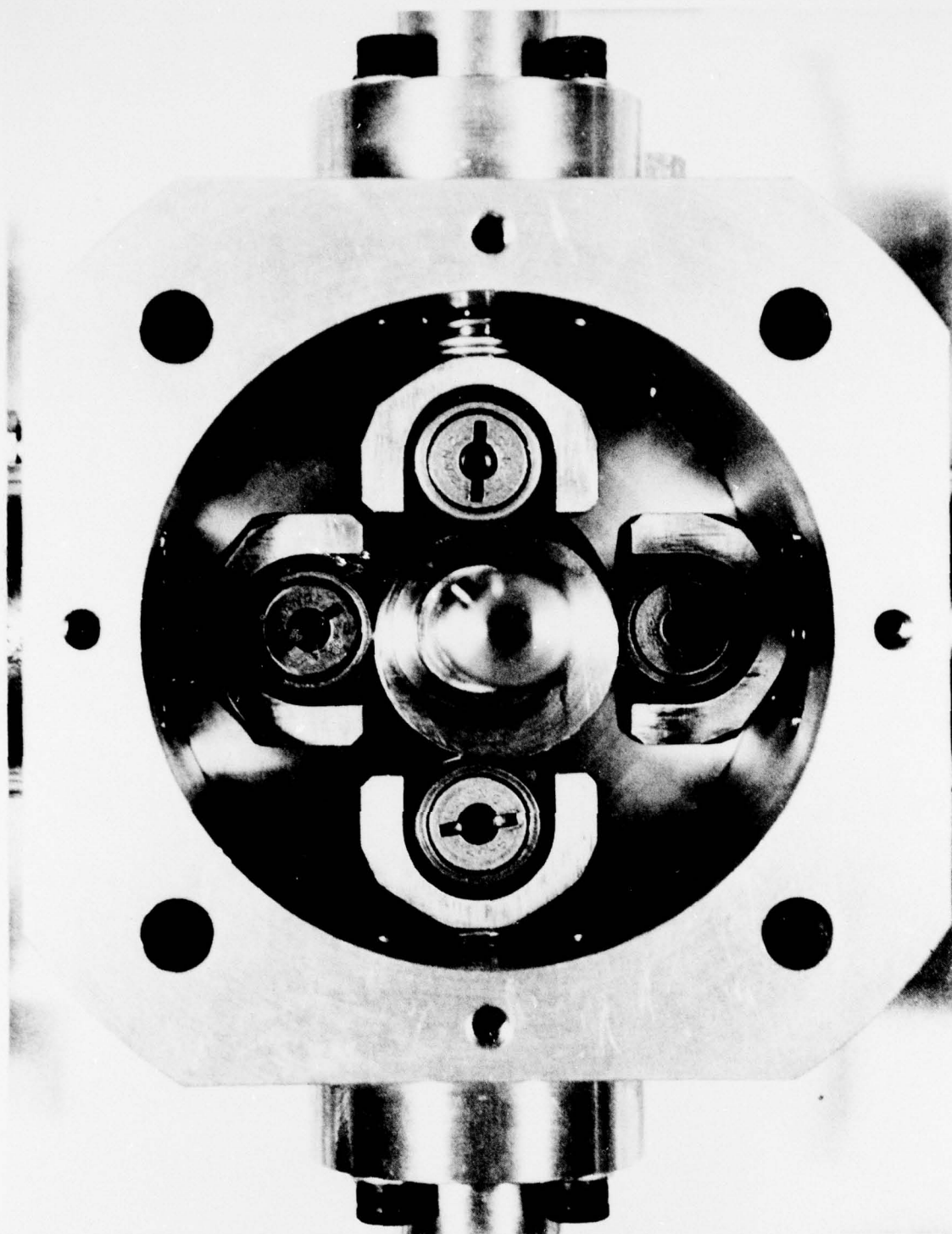


FIG. 3 ENLARGED VIEW OF MAIN CASING WITH FRONT COVER PLATE REMOVED
(The casing was machined from 150mm diameter bar stock)

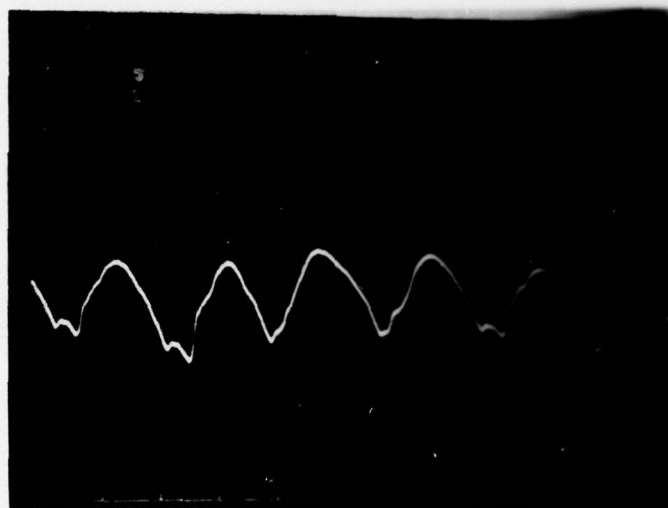


FIG. 4. PRESSURE WAVE FORM AT DESIGN CONDITION OF 20 LITRE / HR 1400 WFL
(Each vertical division represents 35 kPa)

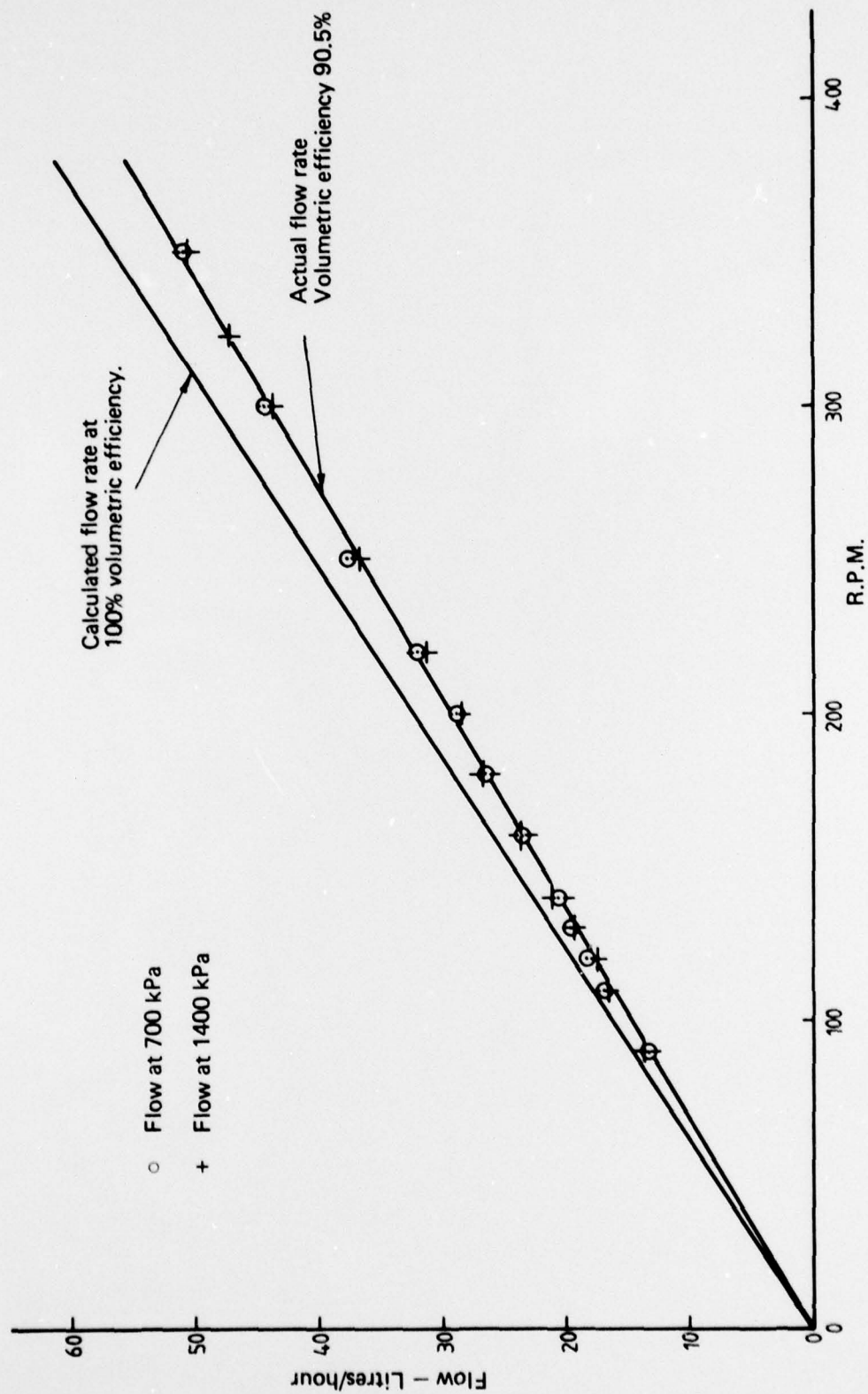


FIG. 5. VARIATION OF FLOW WITH SPEED.

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